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two stars being determined in the usual manner, by observing them on the same night, and in the same position of the instrument, gives the *sum* of their zenith distances : and if on the next or some following night  $\gamma$  Draconis be observed, and after its passage the instrument be turned half round, and the other star observed, then the difference of the measure, as read on the micrometer, will be the *difference* of the zenith distances of the two stars. These sums and differences, thus ascertained on different nights, will be independent of any change that may happen to the instrument in the interval. This method affords the means of determining, with almost unlimited precision, the value of the small equations which become the subject of investigation in the employment of the instrument. Thus all changes of the position of the stars, occasioned by aberration, nutation, &c., will produce double the effect on the small differential or subsidiary angles, as measured by this method. For the investigations of these small equations it will not be necessary to have determined either the exact zenith distance of each star, or the exact difference of their zenith distances, or the absolute magnitude of this subsidiary angle ; its variation from time to time being the only important object of research. The author is led to expect that this property may, at some future period, be applied with advantage in investigations made with moveable zenith instruments.

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March 20th, 1833.

MARK ISAMBARD BRUNEL, Esq., Vice-President, in the Chair.

A paper was read, entitled, " Narrative of the Proceedings of Commander Thomas Dickinson, of His Majesty's Sloop Lightning, while employed in the Enterprise for the Recovery of the Public Stores and other property sunk in His Majesty's late Frigate Thetis, on the south-west side of the Island of Cape Frio." By Commander Thomas Dickinson, R.N. Communicated by P. M. Roget, M.D., and J. G. Children, Esq., Secretaries to the Royal Society. It was preceded by the reading of a letter from the author to the Secretary, explaining the reasons which induced him to lay this narrative before the Royal Society, and place on the records of its proceedings the information it contains relative to the commencement of an enterprise, wholly planned and undertaken by himself, and which, under his superintendence, was, by the great, persevering and meritorious exertions of his officers and crew, most successfully accomplished.

The narrative commences with the statement of the consternation produced at Rio de Janeiro on the receipt of the intelligence of the loss of the Thetis, with a freight of about 810,000 dollars, on the south-west side of the island of Cape Frio, and of the determination of the author, on finding that no one seemed disposed to take any step towards the recovery of the property thus lost, to make the attempt himself, if he could obtain from the Commander-in-chief at that

station, Rear-Admiral Thomas Baker, C.B., orders to that effect. He accordingly exerted himself to obtain every possible information relative to the nature of the coast, depth of water, and other circumstances, which might enable him to judge of the practicability of the undertaking, and of the means necessary for its successful accomplishment; and became convinced that the difficulties and obstacles to be encountered, although numerous and formidable, might be overcome by the employment of the means which suggested themselves to him as practicable on this occasion, if sufficient assistance were afforded him in putting them into execution. He accordingly had models of the proposed machinery made, and submitted them, together with his plans, to the Commander-in-chief, by whom they were approved. He experienced great difficulties in procuring a suitable diving-bell, for it was impossible to obtain any instrument of the kind at Rio de Janeiro, or even any facilities for the construction of one by casting. It at length occurred to him that a ship's iron water-tank might be converted to this use; and being supplied with one from the *Warspite*, he was enabled to render it available for that purpose. The next difficulty was to procure an air-pump, which, after much delay, owing to the tardiness of the native workmen in that country, was at length constructed. The want of air-hoses, however, was a still more formidable obstacle to the success of the plan; but the ingenious contrivances of the author for rendering the common pump hoses airtight, supplied this deficiency; and on a trial which he made with the whole apparatus on the 22nd of January, 1831, it was found to answer completely. The next day he received his orders from the Commander-in-chief, and, sailing on the following day, arrived at the harbour of Cape Frio on the 30th, and immediately proceeded to inspect the coast, and ascertain the situation of the wreck, not a vestige of which was visible. An account is then given of the local circumstances of the Thetis Cove, or inlet, surrounded by almost perpendicular cliffs from 108 to 194 feet in height, with a depth of water varying from  $3\frac{1}{2}$  to 24 fathoms, and the bottom being strewed with huge perpendicular rocks, occasioning these inequalities. These surveys showed that the execution of the plan originally conceived by the author was opposed by so many unforeseen difficulties, that he was obliged to relinquish some parts of it, and resort to fresh expedients for surmounting them. The idea of constructing a derrick then occurred to him; but the materials were wanting, for no trees existed in the island except those in the forests in the interior, which were inaccessible from their distance and the heights on which they grew, and of which the wood was, from its quality, unsuitable to the purpose. His only resource, therefore, was to make it of the fragments of spars saved from the wreck. With great exertions, a circumstantial account of which is given in the paper, the work was at length accomplished; and the result fully equalled the anticipations which had been formed of its utility in affording a stable point of support for the operations with the diving-bell. Previously to the erection of a derrick, however, much had been done by working the diving-bell from a boat, and a considerable quantity of stores and treasure raised. At one time the anxiety

of the author to forward the undertaking, and avail himself of favourable weather, induced him to try the experiment of working by torch-light, which succeeded to a certain extent ; but after a few trials the danger was found to be excessive, and the fatigue to the divers so great as to oblige him to desist.

After the derrick had been for some time in operation, a tremendous sea arose, the shock of which, for want of sufficient materials to support it, effected its destruction ; and a substitute was then resorted to by the setting up of a suspension cable diagonally from the cliffs, which, after great difficulties, was at length effected.

A great portion of the narrative is occupied with the details of the various proceedings, and of the serious impediments which were successively overcome by the zeal, perseverance and extraordinary exertions of the officers and crew, under the orders of Captain Dickinson, subjected as they were, for so long a period, to the greatest privations and hardships, arising from the laborious nature of the work, the unhealthiness of the climate, the attacks of the chigger, producing distressing ulcers in the feet, the annoyance from drifting sand, which penetrated into every place, the exposure to constant wet in huts which could not be made to exclude either wind or rain, and the perils arising from the boisterous gales and tremendous swell of the sea, which the whole ship's company, but more particularly the men in the diving-bell, had to encounter ; forming a combination of difficulties which the author is convinced could have been surmounted by none but British seamen.

After having succeeded so far in the undertaking, and made, at various times, shipments for England of treasure amounting to about three fourths of the whole which had been on board the *Thetis* when she sunk, orders were received by the author, on the 6th of March, to resign the charge of the enterprise to the Hon. Capt. De Roos, of His Majesty's brig *Algerine* ; on the receipt of which he immediately ordered a survey to be taken of the stores, and on the 9th descended in the bell, surveyed the bottom of the Cove, ascertained the position of the remaining stores and a considerable quantity of treasure ; and after having communicated the whole of the results to Captain de Roos, instructed him, his officers and ship's company in the way of working the bell, as well as in the different modes of removing rocks, recovering stores and treasure, and the use of the whole of the machinery, and furnished him with every necessary information for his guidance, he lent twenty of his men to the *Algerine* for their assistance, resigned the charge to his direction on the 10th, and sailed for Rio de Janeiro on the 13th.

Annexed to the paper is a journal of the amount of treasure of various descriptions recovered between the 31st of March, 1831, and the 10th of March, 1832, by His Majesty's sloop *Lightning*.

There was then read an extract of the letter of instructions, bearing date the 10th of March, 1832, from Commander Thomas Dickinson, then of His Majesty's ship *Lightning*, to Commander the Hon. S. F. de Roos, then of His Majesty's brig *Algerine*, on the former re-

signing to the latter the charge and direction of the enterprise for the recovery of the public stores and treasures sunk in His Majesty's late frigate *Thetis*, off Cape Frio.

The Society then adjourned over the Easter Recess, to meet again on the 10th of April.